Evaluation of MerCAP™ for Power Plant Mercury Control

Quarterly Technical Progress Report

July 1, 2004 – September 30, 2004

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DISCLAIMER

ABSTRACT

This document summarizes progress on Cooperative Agreement DE-FC26-03NT41993, "Evaluation of MerCAP™ for Power Plant Mercury Control," during the time-period July 1, 2004 through September 30, 2004. The objective of this project is to demonstrate the performance of MerCAP™, a technology that uses a fixed sorbent downstream of wet and dry scrubbers for removing mercury from coal-combustion flue gas. The project is being funded by the U.S. DOE National Energy Technology Laboratory under this Cooperative Agreement. EPRI, Great River Energy, and Southern Company are project co-funders. URS Group is the prime contractor.

The general concept for MerCAP™ is to place fixed structure sorbents into a flue gas stream to adsorb mercury and then, as the sorbent surfaces become saturated, thermally regenerate the sorbent and recover the mercury. One example includes parallel gold-coated plates. Mercury forms an amalgam with the gold and is removed from the flue gas flowing past the plates. The captured mercury can be subsequently sequestered using a carbon canister or cryogenic trap during regeneration.

In this project, URS Group and its team will conduct tests at two host power plants to evaluate gold MerCAP™ performance downstream of a spray dryer-baghouse and wet scrubber over an extended period of flue-gas exposure. The spray dryer site, identified in this proposal as Site 1, is Great River Energy's Stanton Station, which burns a ND lignite coal. At this site, an array of gold-coated MerCAP™ plates will be incorporated into the outlet plenum of one compartment (6 MWe) of the Unit 10 baghouse. Site 2, the wet scrubber site, is Southern Company Services' Plant Yates, which burns an Eastern bituminous coal. Gold-coated structures will be configured as a mist eliminator and configured downstream of a pilot (1 MWe equivalent) wet scrubber receiving a flue gas slipstream obtained immediately downstream of a full-scale FGD absorber. MerCAP™ will be evaluated for mercury removal during normal boiler operation for periods of six months at both sites.

The ability to repeatedly thermally or chemically regenerate exposed MerCAP™ plates is a critical component to the overall economics of the technology. Therefore, during the longer-term tests, small-scale tests will be conducted to evaluate the mercury removal effectiveness at both sites following repeated regeneration cycles. Tests will be conducted using a 40-acfm slipstream probe device ("Mini-MerCAP™ probe"). Gold-coated substrates from the same production batch used for the MerCAP™ arrays in the larger longer-term tests will be used in the Mini-MerCAP™ probe.

During this reporting period, efforts included the installation of the MerCAP™ array in the outlet plenum of the selected baghouse compartment at Host Site 1, GRE's Stanton Station Unit 10. Following the successful installation of the MerCAP™ array, a period of intensive performance measurements was made with mercury CEMs. Manual Ontario Hydro measurements were also conducted during this period to verify the accuracy of the mercury CEM systems. One set of MerCAP™ gold was successfully regenerated using a chemical regeneration method during this reporting period.

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EXECUTIVE SUMMARY

This document is the quarterly Technical Progress Report for the project "Evaluation of MerCAP™ for Power Plant Mercury Control," for the time-period July 1, 2004 through September 30, 2004. The objective of this project is to demonstrate the performance of MerCAP™ a technology that uses a fixed sorbent downstream of wet and dry scrubbers for removing mercury from coal-combustion flue gas. The project is being funded by the U.S. DOE National Energy Technology Laboratory under this Cooperative Agreement. EPRI, Great River Energy, and Southern Company are project co-funders. URS Group is the prime contractor.

The general concept for MerCAP™ is to place fixed structure sorbents into a flue gas stream to adsorb mercury and then, as the sorbent surfaces becomes saturated, thermally regenerate the sorbent and recover the mercury. One example includes parallel gold-coated plates. Mercury forms an amalgam with the gold and is removed from the flue gas flowing past the plates. The captured mercury can be subsequently sequestered using a carbon canister or cryogenic trap during regeneration. In this project, URS Group and its team will conduct tests at two host power plants to evaluate gold MerCAP™ performance downstream of a spray dryer-baghouse and wet scrubber over an extended period of flue-gas exposure. Testing at each host site will take place for a period of 6 months.

Great River Energy is providing co-funding and technical support to this project and is providing Stanton Station Unit 10 as a host site. Unit 10 fires North Dakota Lignite and is configured with a spray dryer as a dry FGD system, with a downstream baghouse for particulate control. At this site, an array of gold-coated MerCAP™ plates will be incorporated into the outlet plenum of one compartment (6 MWe) of the Unit 10 baghouse.

Southern Company is also providing co-funding and technical input to this project and its subsidiary, Georgia Power, is providing its Plant Yates as a host site for testing. Plant Yates Unit 1 fires a low-sulfur bituminous coal and is configured with a small-sized ESP for particulate control, and a downstream CT-121 Jet Bubbler Reactor (JBR) wet FGD system**.** Gold-coated structures will be configured as a mist eliminator and configured downstream of a pilot (1 MWe equivalent) wet scrubber receiving a flue gas slipstream obtained immediately downstream of a full-scale FGD absorber.

The ability to repeatedly thermally or chemically regenerate exposed MerCAP™ plates is a critical component to the overall economics of the technology. Therefore, during the longer-term tests, small-scale tests will be conducted to evaluate the mercury removal effectiveness at both sites following repeated regeneration cycles. Tests will be conducted using a 40-acfm slipstream probe device ("Mini-MerCAP™ probe"). Gold-coated substrates from the same production batch used for the MerCAP™ arrays in the larger longer-term tests will be used in the Mini-MerCAP™ probe.

MerCAP™ technology has been successfully tested in small-scale units installed at the proposed test sites. Results of the proposed study will verify this performance at a larger scale and over a longer period of gas exposure and will provide data required for assessing the feasibility and costs of a full-scale MerCAP™ application.

The installed MerCAP™ Full-Scale array has now been in service for 915 hours and is operating at nominally 30%-40% mercury removal efficiency. Initial removal rates were higher than previously measured at this geometry (+90%) but degraded over the first 48 hours of operation before stabilizing at 30%-40% performance. While the overall long-term removal performance is lower than the target of the program, the technology is still operating well.

In addition to the standard parallel plate configuration for installation of the MerCAP™ array, a set of gold plated screens were installed in a perpendicular to flow orientation to evaluate removal performance. Calculations were conducted to determine the SCEM measurements performed on the perpendicular plate configuration showed no appreciable mercury removal.

One substrate in the mini-MerCAP™ probe was chemically regenerated resulting in mercury removal performance similar to an unexposed substrate.

EXPERIMENTAL

Summary of Progress

The current reporting period, July 1, 2004 through September 30, 2004, is the fourth full technical progress reporting period for the project. Efforts during the current period focused on tasks associated with installation and long-term flue gas exposure testing of the full-scale MerCAP™ array at Site 1. Specific activities included the installation and performance monitoring of the MerCAP™ array at Site 1. Ontario Hydro flue gas measurements were performed for the baseline and MerCAP™ testing cases. Performance monitoring was carried out for the first mini-MerCAP™ substrate regenerated using chemical regeneration. Table 1 lists the planned and completed milestones for the first year of this project. A summary of each activity carried out during this reporting period is provided below.

Table 1. Schedule for Year 1 Milestones for this Test Program.

Milestone	Description	Baseline	Expected Completion	Actual Completion
1	Submit Hz. Subs. Plan	Q4 2003	Q1 2004	Q1 2004
2	Submit Test Plan	Q4 2003	Q1 2004	Q1 2004
3	Frame Installation/Baseline Monitoring Site 1	Q1 2004	Q2 2004	Q2 2004
4	Site 1 Gold Installation, Intensive Testing	Q1 2004	Q2 2004	Q3 2004
5	Start of Long Term Testing, Site 1	Q1 2004	Q3 2004	Q3 2004
6	End of Long Term Site 1, Gas Char Tests	Q3 2004	Q2 2005	
7	Site 1 Review/ Site 2 Planning Meeting	Q3 2004	Q2 2005	
8	Frame Installation/Baseline Monitoring Site 2	Q4 2004	Q2 2005	

Sub-Contracts

No sub-contracts were awarded during this reporting period.

Task Activity Summary

Table 2 lists the current activity status of the primary tasks for this program. The Stanton MerCAP™ testing had been delayed in the first quarter of 2004 due to operational issues and testing carried out under another NETL-funded test program at the host site.

Table 2. Project Activity Status.

Task Number	Description	Planned % Completion	Actual % Completion
1	Project Planning	50%	50%
2	Stanton MerCAP™ Testing	65%	65%
3	Yates MerCAP™ Testing	0%	0%
4	Economic Analysis	0%	0%
5	Project Management & Reporting	30%	30%

Problems Encountered

No technical problems were encountered during this reporting period. Prior tests of the MerCAP™ substrates, performed shortly before starting this program, showed greater variation in performance levels and earlier sorbent degradation than experienced in previous tests conducted by EPRI (2002–2003). A decision was made to install ¼ of the total MerCAP™ substrates into the full-scale (Unit 10) baghouse compartment until stable operating conditions were observed or specific causes for early degradation were identified. The full-scale compartment design utilizes 4 individual duct sections to hold and support the gold substrates. One of the four duct sections was thus brought into service. Perforated plates/screens were installed across the other three sections to simulate comparable pressure drop and equivalent flows across all four channels. The balance of the gold substrates will be installed in the compartment during the next reporting period.

Plans for Next Reporting Period

The next reporting period covers the time-period October 1 through December 31, 2004. During the quarter, periodic performance monitoring will be performed using mercury semi-continuous emissions monitors (SCEMs) to evaluate and characterize the performance of the full-scale MerCAP™ array installed at the Stanton Station Unit 10 baghouse. During the quarter, the host site will undergo a fuel source switch from ND Lignite to sub-bituminous Powder River Basin coal (PRB). Extensive SCEM measurements will be made during this fuel switch to evaluate the impact, if any, on the MerCAP™ technology performance.

Stanton Station has historically utilized North Dakota lignite from the Coteau Freedom Mine. The new contract will be supplying Powder River Basin sub-bituminous coal to the host site. MerCAP™ technology has been successfully tested on the pilot scale with both types of these fuels downstream of scrubbers. The current schedule for the fuel switch is November 1, 2004. Approximately 1800 hours of the 4400 hours of the long-term demonstration will have been completed at this time. The remaining balance of the MerCAP™ demonstration will be conducted with the host utility burning the alternate PRB fuel.

The balance of the MerCAP™ gold substrates procured for this program will be installed in the full-compartment. One of the four duct sections will be configured for a ½" plate spacing versus the 1" plate spacing currently being used. This alternate design parameter should achieve

significantly higher removal rates (>55%), per the goals of the program. This additional full-scale parametric data will be used to adjust the current model inputs for future designs.

Additional regeneration tests will be conducted to further evaluate the impact repeated regeneration cycles have on the mini-MerCAP™ substrate. Thermal regeneration tests utilizing the mini-MerCAP™ probes will be initiated and further chemical regeneration cycles will be performed.

The next reporting period will also include initial planning for the MerCAP installation at Plant Yates. Efforts will include coordination with Southern Company to develop a design to retrofit the gold MerCAP screens into their existing pilot scrubber on Unit 1. Short term MerCAP screening tests and coupon tests will also be conducted during the next quarter while URS personnel are on site for a long term activated carbon injection test as part of a DOE testing program.

Prospects for Future Progress

During the subsequent reporting period (January 1 through March 31, 2005), completion of the long term testing is planned for the MerCAP™ installation at Stanton. Work activities will include periodic mercury measurements across the large-scale unit, as well as mercury measurements made across the mini-MerCAP™ probes with further attempts at regeneration.

This reporting period will also include the finalization of the design and procurement of materials for the MerCAP installation at Plant Yates. Installation of this unit is scheduled for the end of the first quarter of 2005 or the beginning of the following quarter. Baseline mercury measurements will occur prior to the MerCAP installation and initial mercury measurements will be conducted immediately after the unit is put into service.

RESULTS AND DISCUSSION

During this reporting period the full-scale MerCAP™ array was installed into one compartment of the host unit's baghouse. Figure 1 shows the fully installed MerCAP™ array with gold plates at 1-inch spacing. The first flue gas was pulled through the MerCAP™ array on August 21.

Figure 1. MerCAP™ Array in Stanton Station Baghouse Compartment

After completion of the installation of the gold plates into the MerCAP™ frame, extensive SCEM measurements were made to characterize the initial performance of the MerCAP™ array. Initial performance (first 24 hours of service) of the installed gold was very good, with upwards of 90+% mercury removal across the plates. However, as has been observed in previous small-scale MerCAP™ tests, the initial performance degraded. During the initial performance measurements, the mercury removal became fairly steady at 40%-50% across the plates. Figures 2 and 3 show the mercury data collected with SCEM measurements and the mercury removal performance versus the service time for the installed gold.

During the initial performance monitoring manual Ontario Hydro measurements were made to verify the accuracy of the SCEM measurements. Measurements were made on September 8 and 9, 2004. Two sets of measurements were made. The first set of Ontario Hydro measurements were made simultaneously at the inlet and outlet of the MerCAP™ array. The second set of Ontario Hydro measurements were made simultaneously at the inlet and outlet of an empty baghouse compartment chamber. This second set of measurements serves as the baseline to which the MerCAP™ removal can be compared. During both sets of Ontario Hydro

measurements, the mercury SCEMS were logging data at the inlet and outlet. As of the date of this report the results of the Ontario Hydro measurements were not available.

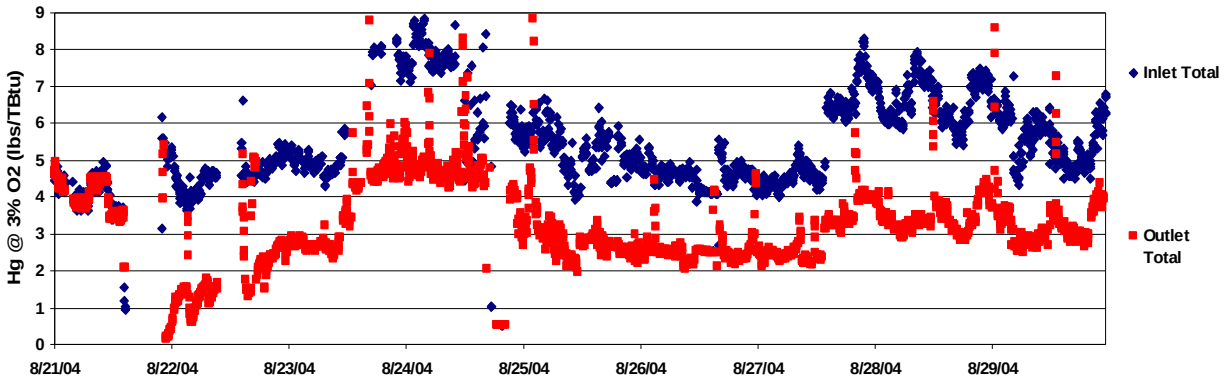

Figure 2. SCEM Mercury Data

Measurements were made across the MerCAP™ array approximately one month after the initial installation. During these measurements it was observed that the overall removal efficiency of the MerCAP™ array had dropped to 30% - 40%. Figure 4 shows the SCEM measurement data collected at the one-month interval.

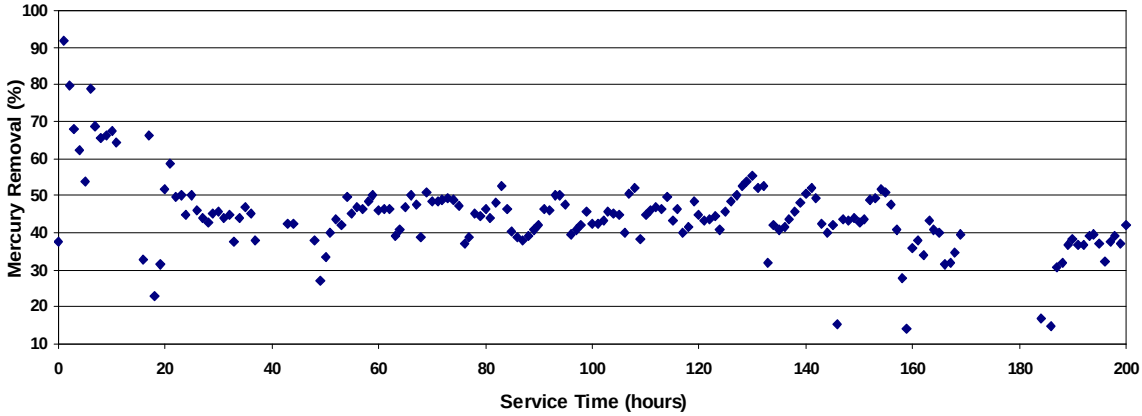

Figure 3. Mercury Removal Performance versus Time in Service

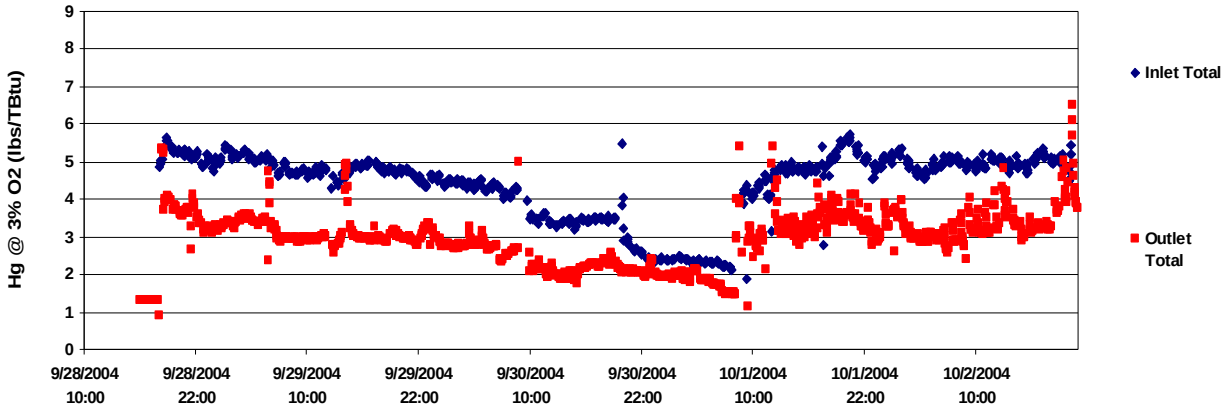

Figure 4. SCEM data at One-Month Interval

A single mini-MerCAP™ substrate was chemically regenerated and placed back in service during this reporting period. The substrate appeared to have been degraded to the point that little to no appreciable mercury removal was being achieved prior to the chemical treatment. After regeneration the substrate was placed back in service and demonstrated similar removal performance to unexposed substrate. Figure 5 shows the removal rate versus service time for the series of measurements made on this particular substrate following chemical regeneration.

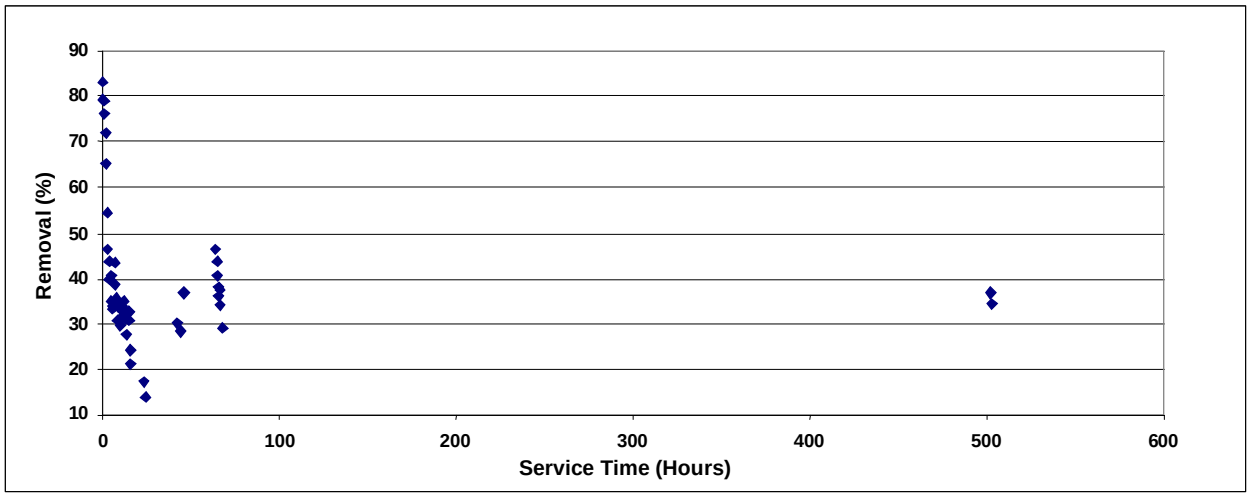

Figure 5. Regenerated Gold Performance versus Service Time

CONCLUSION

The installed MerCAP™ full-scale array has now been in service for 915 hours and is operating at nominally 30%-40% mercury removal efficiency. Initial removal rates were higher than previously measured at this geometry (+90%) but degraded over the first 48 hours of operation before stabilizing at 30%-40% performance. While the overall long-term removal performance is lower than the target of the program, the technology is still operating well.

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One substrate in the mini-MerCAP^{TM} probe was chemically regenerated and now shows mercury removal performance similar to an unexposed substrate.

REFERENCES

No references.